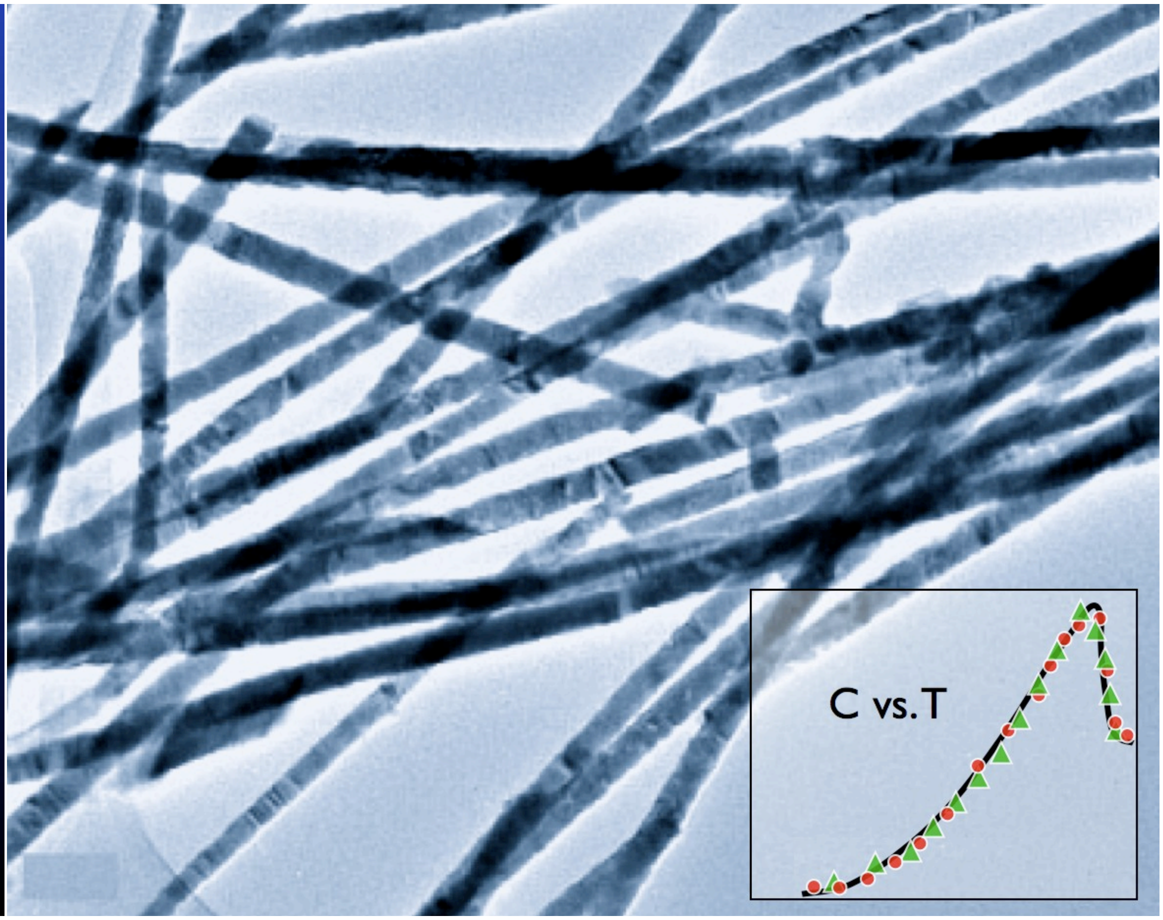
1DHEATCAPACITY

Penn State MRSEC



Zinc nanowires only 23 nm wide show the same thermal response to the superconducting transition as do wires ten times wider.

One-dimensional superconductors squeeze the heat

IRG3

Superconductivity, a state of zero resistance against flow of current, should not be possible in a one-dimensional system. But to act truly one-dimensionally, the wire must be thinner than the so-called superconducting coherence length, the characteristic size of the correlated pairs of electrons that coalesce to form the superconducting state. Wires this thin are not longer perfectly conducting, but manifest a residual resistance due to jumps and shifts in the superconducting properties along the length of the wire.

Experiments on one-dimensional wires to date have measured only electrical properties, such as the resistivity. But the specific heat, meaning the resistance of the material against changes in temperature, is arguably the most revealing experimental signature of transitions into the superconducting state. However, there not yet been any measurement of specific heat for any one or even two dimensional electronic system (superconducting or otherwise), because the heat signal from an ultrathin low-dimensional system is swamped by the thermal response of the much larger three-dimensional substrate on which is sits. MRSEC researchers have now for the first time measured the specific heat of a one-dimensional electronic system by aligning billions of zinc wires at once within a nanoporous alumina membrane. Surprisingly, zinc wires only 23 nm wide show just as sharp a signature of the superconducting state as do wires ten times as thick: Although one can "squeeze out" the perfect electrical conduction of an ultra-thin superconducting wire, the characteristic thermal response of a superconductor remains.

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